Peer Assessment and Group Work in Civil Engineering Education

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Summary

The Civil Engineering Course of the University of Minho in Portugal started with peer assessment in the first year of the academic year 2004/05. The implementation of peer assessment at this course was a consequence of the successful implementation of peer and self assessment at other engineering courses of the University of Minho. This article will outline the motives for the implementation of peer assessment, the expected and obtained effects and will delineate the group work processes that are put into action at the first year of the Civil Engineering Course. During the semester, three assessment moments take place in two subjects, with a different assessment task at each moment. Students are supposed to assess the work of the peers, supported by well defined criteria that are partly the results of a negotiation process between students and teacher. They subsequently mark the work of their colleagues and provide a clear justification for each given mark. The aim of this method is to involve them in the subject, enhance their motivation and in that way deepen their learning. Advantages and disadvantages of peer assessment from both the teacher's and the students´ perspective are discussed. The results that have been obtained so far, point at a successful implementation of peer assessment. The implementation process relied on strong institutional and pedagogical support, that were considered crucial to the changes that were realized.

Keywords: assessment, civil engineering, group-work

1. Introduction

Student learning is one of the core processes at a university, providing legitimacy to universities as opposed to research institutions. Quality of learning is considered the 'heart' of quality of education, being effective learning a prerequisite for the transformation process of the students. Therefore, the learning approach must be aimed at enabling them to understand and internalise their materials in the first place and recall, use and apply effectively in a later stage when necessary. Engineering students in the final years of their degree at the University of Minho have specific problems using knowledge that they should have constructed in their first and second year. Supposedly, these problems are caused by an ineffective approach to learning. Having a surface approach to learning, students do not fully understand what they are learning. They can reproduce facts and sometimes demonstrate standard skills, but they are unable to critically reflect on what they have learned and use these contents later on. It is supposed that a deeper approach to learning will help students to understand their materials better [1].

There are various ways to influence the learning approach of students towards a deeper one. The previous knowledge and experiences of students, the academic staff and the way they teach, the curriculum and the assessments methods all influence the learning process of students. This paper discusses different concepts of assessment in higher education and describes critically a recent experience undertaken at the Civil Engineering course of the University of Minho in which assessment is used as a tool to influence student learning.

2. Assessment in Higher Education

Assessment –or evaluation of learning- of students has a significant impact on student learning. In literature, assessment is often mentioned as a way to influence student learning [2, 3, 4, 5, 6, 7]. Assessment of learning is considered an instrument to change learning. Dochy and Moerkerke [6] point out that as assessment changes, learning and teaching will change as well. Although there may be many internal and external forms of motivation of a student, a good test result is normally a strong incentive for a student not only to learn, but also to learn in a certain way. For example, if the assessment demands memorising facts in order to pass exams, that activity is adopted by many students [8]. In sum, students adapt their learning strategies to what is required by the assessment.

The awareness is growing that the civil engineer of tomorrow should be equipped with multidisciplinary knowledge, appropriate skills and attitudes as well as prepared for life-long learning, therefore the use of new teaching and learning strategies is highly recommended [9, 10]. The skills and attitudes associated with the short term (5 – 10 years) societal requirements emphasise the importance of problem-solving, critical thinking, creativity, learning to learn, lifelong-learning, professional and ethical responsibility, self-starter-self-sufficient-autonomy, negotiation and administrative skills, leadership, communication and interpersonal skills, teamwork, self-assessment as well as decisiveness, adaptability and respect of different cultures [10].

It is considered that if students are to be autonomous, reflective and independent learners, assessment methods need to reflect these requirements as well [11]. Therefore, institutions, course directors or individual teachers can use assessment to change the quality of student learning. Apart from the short-term effect of assessment on learning within a subject, Thomson and Falchikov [8] also argue that study patterns which are established early in a university career can persist into second and third year. Teachers need to realise that the way they are shaping the learning processes of their first year students, may have a long term influence on student learning during their entire course.

Boud *et al.* [12] refer to some important effects of assessment on learning. Firstly, assessment traditionally emphasises the individual. In many institutions, individual, competitive norm referenced testing is the common practice. Competition seems more important than cooperation and criterion referenced assessment is relatively rare. In the second place, assessment exercises power and control over students. It is the main mechanism used to control students and to promote forms of self-surveillance which encourages following a set of strict assessment rules instead of learning. Boud [12] also points at the so-called backwash effect on learning that inappropriate forms of assessment appear to encourage a surface approach to learning (…) that is they emphasise rote learning, conforming the narrowest interpretations of assessment tasks and working to `beat the system´ rather than engage in meaningful learning [12, p. 416]. A deep approach to learning is discouraged by an overload of assessment tasks.

The recent changes in higher education like project-based learning, group learning and other methods aimed at the construction of knowledge by students, ask for different assessment methods [13] that will

have to go beyond measuring the reproduction of knowledge. That is because this kind of assessment does not do justice to forms of learning involving the construction of meaning by the student and the development of strategies for approaching new problems and learning tasks [14]. According to Dochy [15], assessment not only refers to measuring, but also to involvement of students, application of knowledge and skills, integration in the learning environment, knowledge construction instead of knowledge reproduction and real life situations. In this concept, students are regarded as independent, autonomous and exploring individuals who direct their own learning processes, so their role in the assessment process is different and depends less on the teacher and more on the student. This attitude fosters autonomy and responsibility. In fact, one of the fundamental changes in this assessment concept is the shift of responsibilities from the teacher to the student. The teacher is no longer the only person responsible for the assessment process. The student becomes, to a large extent, responsible for his own assessment and is in charge of various stages in the assessment process. In so-called student-centred assessment, as opposed to teacher-centred assessment, students are responsible for the definition of criteria, the correction and grading of work and for feedback. They assess their own work or the assignments or test papers of their peers in groups or individually.

Table 1 summarises the main differences between traditional, teacher-centred assessment and student-centred assessment. The division between student-centred and teacher-centred assessment is not as rigid as suggested. Especially at the initial stages of implementing student participation in assessment, teacher and student responsibility are very much shared. During the semester, student develop gradually towards a larger responsibility for their own assessment.

Table 1. Teacher-centred and student-centred assessment.

Assessment tasks	**Teacher-centred assessment**	**Student-centred assessment**
Defining assessment method	Teacher	Teacher
Defining criteria	Teacher	Students/teacher
Evaluating work	Teacher	Students/teacher
Grading	Teacher	Students/teacher
Giving feedback	Teacher	Students
Justifying grades	-	Students
Making recommendations	-	Students
Reflecting on assessment	-	Students

By enhancing student responsibility, students are more involved in the technical contents and become more motivated. Assessment is no longer a process that happens to them; it becomes part of their own reflective process.

Derived from this broader concept and the perception of its importance, assessment and instruction are becoming more intertwined. Assessment is no longer an isolated, summative activity, with little connections to learning activities. Instead, it is integrated in the instructional process and can be regarded as a tool to enhance the learning processes of the students [15].

3. Implementation of peer and self-assessment

Based on research in earlier projects at engineering courses at the University of Minho, a project was started at the first year of the Civil Engineering Course of this university to implement peer and self assessment in two subjects: Geology and Introduction to Civil Engineering.

The difference is that instead of being applied to groups of twenty such as in textile engineering of up to fifty students, it was now directed to an intake of around 200 students of the first year in the first semester. Of these about 150 students took the peer-assessment model while the remaining group followed the classical final exam model.

The choice of these two subjects was due to the fact that they are the only ones corresponding directly to Civil Engineering topics and taught by teachers of this Department. Normally, they are the ones with better passing rates and they appeal more to students as in these two subjects they are directly exposed to concepts of civil engineering.

The remaining four subjects belong to the Mathematics, Physics and Informatics Departments. It was thought to be easier to develop this experience with more popular disciplines and the Council of Engineering Courses provided an educational specialist to give specific pedagogical support.

3.1 Description of student population

As already mentioned, the sample consisted of first year Civil Engineering students. All students who were not repeating the first year and were not working students were required to do the new assessment scheme. Figure 1 shows the characteristics of the student population.

Table 2. Characteristics of the student population

Subjects	Male	Female	Total
Geology	111 (77%)	34 (23%)	145
Introduction to Civil Engineering	118 (81%)	34 (19%)	152

Working students and students who did the subject for the second time were allowed to participate in a final exam only. The majority of student population consisted of male students: 77% and 81%, typical of this specific engineering course.

In Geology, the studied topics included minerals and their properties; the structure and composition of the earth; rocks: igneous, sedimentary and metamorphic; geological structures: folds, faults and joints; foundation geology; rock mechanics; topographic profiles and scales; land surveying using simple instruments: compasses and tapes; surveying of surface rocks using compasses, visual identification of rocks, geological maps, section drawing on geological problem maps; geology of underground works: tunnels, galleries and excavations, prospecting of stone quarries; rock blasting on roads and quarries. In Introduction to Civil Engineering (IEC), the most relevant periods of the history of construction were studied, namely architecture in Ancient times, in Egypt, Greece and Rome, the evolution of the basilica typology; from the Roman basilica to the Gothic cathedral, the use of classical elements, from the Renaissance to the Baroque periods, the 19th century architecture and cities after the industrial

revolution, the 20th century introducing the modern movement, contemporary architecture and town planning. The development of construction systems for building, the split between architecture and civil engineering, the analysis of some recent master works, the increasing importance of environmental aspects and rehabilitation issues, were the topics under analysis.

3.2 Description of Method

The teaching and learning methods were modified, following a bigger change in the curricula, reducing hours of classes and promoting self learning by students. The convergence to the Bologna Agreement is under way and the course had a shift in the curricula, being transformed into a 4+1 year course, not the previous 5 standard year course. The two subjects were located in the first semester of the first year, advancing one semester. While the situation is different, the aims and objectives of the subjects in terms of topics remained the same. While in Geology, the aim of this course unit is to teach the basics of rock and soil origin and their properties for civil engineering purposes, in Introduction to Civil Engineering the aim of this course unit is to introduce students to the history of western architecture and civil engineering, highlighting major innovations across time and recent trends.

Both subjects implemented various assessment moments in which students worked individually or in groups on assignments or tests and evaluated the results of their peers or peer groups. The work in groups was debated together by the lecturers of the two subjects and the educational specialist. A first common decision was the composition of the groups that was previously arranged. Gender and entrance exam grades were taken into consideration to assign the respective members to each group. This was not normally done at the University, especially at the degree course of Civil Engineering where students normally select their team members. The high number of students provides the excuse for this typical lack of organization. Nevertheless, while in IEC the average number of team members varied from six to eight, in Geology the highest accepted number was five. This produced a somewhat undesirable effect of not being able to match the teams in both subjects. But Geology, having lab classes and smaller teams determined the composition of the bigger teams of IEC, upon common agreement so that there would be some spirit of class which effectively was detected in the most committed students. Discussions would generally be enlarged to the teams present independently of the team composition as they were together in the other subject. This growing up of group, class and course commitment was visible in the voluntary generation of a yahoo group, something unheard of in the second month of a first year start-up at University.

Each subject had three moments of formal assessment. In Geology a fourth moment consisting of a final individual test was given. At the first moment of assessment in Geology, students had to analyse geological maps using special software. This assignment was performed in groups of four or five students, composed by the teachers. At the second assessment moment, students gave powerpoint presentations about a study visit that took them to the dam of Venda Nova II, the dams of Venda Nova and Paradela, the old village of the EDP (Electricity Company) and the village of Sirvozelo. This study visit was a combined effort of both subjects. In the third assessment moment students applied empirical classifications to rocks. The fourth assessment moment was a final test at the end of the semester.

At Introduction to Civil Engineering, the following assessment moments were implemented: a group PowerPoint presentation on a specific period of the history of construction; a group short report on places visited during the field-trip and an individual test. This last assessment scored the same to the final mark as the two others together.

4. Discussion of Results

Apart from the results that are soon to be expected on the learning styles of students, the following results have been identified so far. Firstly, students started working actively on the subject material at the first week of the semester. As opposed to traditional exams that do not encourage students to start studying long before the exam, the students who were in these subjects had to start looking into the subject material seriously right at the start. They became more involved in the subjects and therefore were more present in classes. Introduction to Civil Engineering had one weekly lecture of two hours and although these hours did not require attendance, most students were present at each lecture. Geology consisted of lectures and lab classes. The latter ones were compulsory.

The implementation of peer and self assessment in two subjects of one year at the same time required a solid coordination between the different teachers of both subjects in order to prevent a serious overload of students. The three teachers of Geology had to coordinate with the Introduction to Civil Engineering teacher at what dates assessment moments could take place to ensure that no coincidental dates would occur. Students´ weekly workload was taken into account. Apart from this kind of practical coordination, another joint effort took place by organising the study visit together in such a way that both subjects could benefit from the same visit from different points of view. The visit as described above was the first visit that took place in the very first semester for first year Civil Engineering students and served as a strong motivation for the first year students.

Because of the frequent assessment moments, students were in regular contact with their teachers, especially with regard to Introduction to Civil Engineering (IEC). As their first assignment was rather open, about half of the students frequently consulted the teacher to find out whether they were preparing their presentation in the right way with an adequate content. During these contact moments, the teacher received important feedback on the performance of students, knowing which students were involved in and how they were dealing with the different parts of the materials. The questions students had to formulate at the end of their presentation did not only serve as a preparation for the final test, but also provided information to the teacher on the level of understanding of the students. The first assessment moment of IEC turned out to be a useful preparation for the second assessment moment of Geology, where students also had to give a presentation. In IEC, students were confronted with the fact that the teacher chose one of the two students that would do the presentation. The other presenter was chosen by the students. The obvious difference in presentation skills due to lack of preparation became very clear to the students and made them aware of the importance of a solid preparation. As the presenter in Geology was appointed by the teacher, all students in a group had to be prepared for the presentation and they could not leave this to just one student who felt more comfortable doing the presentation. The students´ responsibilities were gradually increased, building on their experience, independent of in which subject they had acquired the experience. The lecturers also kept refining their criteria and standards, interfering when the difference between grades given by students and teachers were larger than 10% (in Geology) and 20% (in IEC).

Table 3 summarises the advantages and disadvantages of peer and self-assessment and group skills as experienced in IEC and Geology.

Table 3. Positive and negative aspects of peer and self-assessment and group work in IEC and Geology

Point of view	Peer assessment		Group work	
	Positive	**Negative**	**Positive**	**Negative**
Students	• Accountability • Transparency • Reflection on performance • Revision of contents	• Lack of confidence in assessment skills • Stress • Change of passive role	• Development of wide range of competencies • Group work skills • Social interaction with colleagues	• More time consuming • Initial resistance against teacher-composed groups • Planning and time management difficulties • Lack of group skills
Teacher	• Accountability • Explicit criteria discussion • Shared responsibilities with the students • Better insight in level of accountability for group performance	• More time and effort • More management tasks • Less time for technical contents	• More motivated students • Better insight in students´ attitudes towards work • Shared responsibilities with the students	• Time consuming supervision of groups • Less time for technical contents • Extra time necessary for supervision of "soft" skills

The variety of assessment tasks in the two different subjects enables students to show their capacities in various areas. Apart from individual exams and tests, students had to prepare presentations and write reports in a group. This variety of assessment methods can be considered helpful in the development of different competencies. Students are not only trained to write exams, but start developing writing, presentation, communication and group work skills right at the beginning of the first semester.

5. Conclusions

Based on earlier studies it is supposed that students have deepened their learning style [16] and have changed their approaches due to the changes in assessment methods. Based on the results described above, it can be concluded that the effects of the assessment changes are positive. The involvement of students has increased and the great majority of students in both subjects actively participated in the subjects right from the beginning of the semester. The experience in the first semester of 2004/05 established a solid foundation for further work along this vector of emphasising peer and self-assessment and group work. Even though Civil Engineering is considered a traditional course with a long history of teaching and learning methods, the implementation of new assessment methods and the mainly positive reactions of students and teachers showed the opportunities for gradual shifts towards more learner-centred engineering education. The change of assessment methods in two subjects simultaneously favoured the active participation of students, teachers and supporting staff. There was a mutual reinforcement of efforts of both subjects, which contributed to an institutionalisation of the change process. The support of the educational specialist has proven important for the initial stages of implementation as well as for the monitoring during the semester. The experiences of the first semester

serve as a starting point for the second semester, in which the implementation of peer and self-assessment is being continued in two other subjects.

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